UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service, Grain Division
Washington 25, D. C.

PURITY AND IDENTIFICATION OF SEEDS 1/

The Seed Producing Organs of the Flower (fig. 1)

PISTIL

Stigma (a), the tip of the pistil which receives the pollen.
Style (b), the portion of the pistil between the stigma and the ovary; sometimes so reduced it appears to be lacking.
Ovary (c), the hollow, swollen basal portion of the pistil consisting of: (1) Pericarp, the ovary wall, and (2) Ovule, one or several, the structures which after fertilization become the seed.

STAMEN

Anther (d), the structure at the tip of the stamen which produces the pollen.
Filament (e), the thread-like part of the stamen which supports the anther.

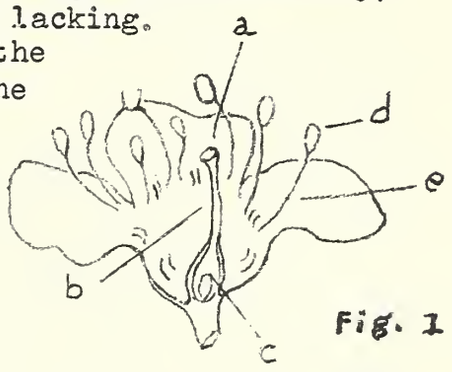


Fig. 1

The pistil is made up of one to several structures called CARPELS. A simple pistil consists of one carpel as, for example, the pea pod with its single cavity. A compound pistil consists of 2-several carpels, as in Mallow. The carpels may be free or united.

The True Seed

The fertilized, mature ovule is the true seed. It consists of an embryo, with or without nutritive tissue (endosperm), and a protective covering, the seed coat. For example, the pod of the bean with its matured ovules (beans) is the fruit, but the beans within the pod are the true seeds.

Fruit

Botanically, a fruit is a matured ovary, consisting of the pericarp, sometimes with other parts adhering to it, and the matured ovules (true seeds).

There are two general classes of fruits: Dry and fleshy. The dry fruits may be dehiscent, splitting open when ripe, or indehiscent, not splitting open. Indehiscent fruits are the units comprising the seed sample in many grass crops, some legumes, and other crops. Of the fleshy fruits, seeds of only one form, berry, occur commonly in seed testing. In such fruits the seeds are embedded in a fleshy pericarp, as in tomato and peppers. Other forms include the stone fruits, and aggregate fruits such as strawberry.

1/ Only the most essential morphological features and terminology employed in seed testing are included. The structural features characteristic of the seed of the more important plant families is described, namely: Gramineae, Leguminosae, Cruciferae, Polygonaceae. For further study reference is made to the following publications.

Botany for Seed Analysts, by W. H. Wright, obtainable from the Sec.-Treas. of the Soc. of Commercial Seed Technologists.

Investigations in Seed Classification by Family Characteristics, by Duane Isely, obtainable from the Sec. of the Assoc. of Off. Seed Analysts.

Albina F. Musil, Seed Technologist. February, 1956.

Some Common Kinds of Fruits (Fig. 2)

Dehiscent fruits -

Legume or true pod (A): Carpel 1, splitting along two sutures. Ex., pea, vetch.
Silique (B): Carpels 2, separating at maturity, leaving a persisting partition wall. Ex., crucifers, except Raphanus.
Follicle: Carpel 1, splitting along one suture. Ex., milkweed.
Capsule: Carpels 2 or more, dehiscing in various ways as, for example, by pores at the top as in poppy or down the middle as in lilies.

Indehiscent fruits -

Achene (C): 1-seeded, the seed attached to the pericarp at one point only. Ex., sunflower, dock.
Caryopsis: 1-seeded, the pericarp firmly fused to the seed coat throughout. Ex., grains of grasses, Sporobolus excepted.
Schizocarp (D): Carpels 2 or more, united and splitting apart at maturity. Ex., mallows, umbellifers (Carrot family).
Mericarp (D): One of the two achene-like carpels of the carrot family.
Loment (E): A legume which is constricted between the seeds and breaks up crosswise into distinct joints at maturity. Ex., Aeschynomene, jointvetch.

Cleistogamous fruits: Produced from buds or florets that are self-pollinated without opening. The fruits usually differ in appearance from those produced from open flowers of the same species. Compare Manual figs. 67-68; 228-229.

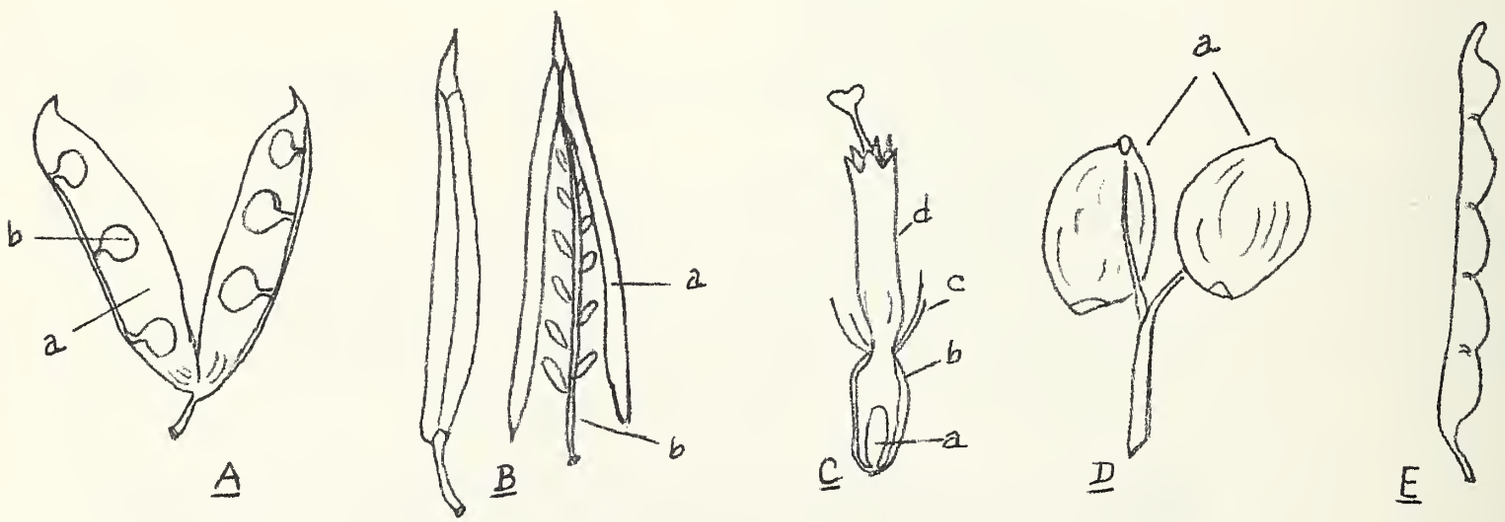


Fig. 2.-A. True pod: (a) Pericarp, (b) true seed.
B. Silique of mustard: (a) Pericarp, (b) partition wall with attached seeds.
C. Achene of sunflower: (a) Ovule, (b) pericarp, (c) pappus, (d) flower.
D. Schizocarp, fruit of carrot family: (a) Mericarp.
E. Loment, showing constrictions in pod between the seeds.

Terms Frequently Used in Seed Identification

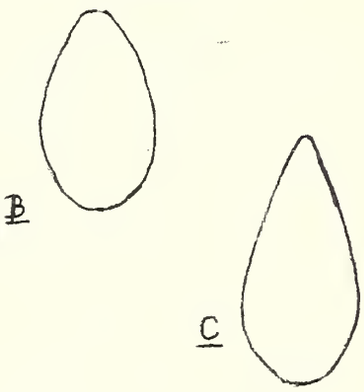
Shapes of Seeds (as they appear in outline)

Linear: Several times longer than wide and of about the same width throughout.
Oblong: About twice as long as broad, the sides nearly parallel, the ends obtusely pointed, the points about equal.
Elliptic or Oval: Broadest at the middle, the two ends pointed and approximately alike. (A).

Narrowly Elliptic: About twice as long as broad.
Broadly Elliptic: Length only slightly more than width.

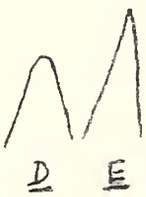
Ovate: Egg-shape, with the broader end at the base. (B).
Obovate: Egg-shape inverted, broad end at the top.

Orbicular: Round or nearly so, scarcely tapering at top and base.
Lance-shaped: Longer than wide, the widest portion below the middle, tapering to both ends but the points unequal. (C).



The Apex and Lemma and Palea

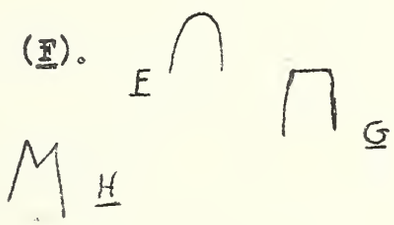
Acute: Ending in an acute angle but not a prolonged point. (D).
Acuminate: The apex prolonged into a narrow, tapering point. (E).



Obtuse: The apex bluntly pointed or rounded. (F).

Truncate: The tip as if cut off crosswise.

Bifid: Two-cleft or two-lobed. (H).

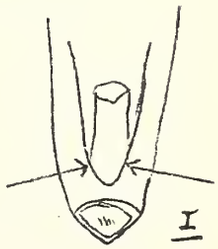


Pubescence

Glabrous: Devoid of hairs.
Pubescent: Covered with hairs, usually applied to short, soft hairs.
Hirsute: Pubescent with straight, somewhat stiff hairs.
Hispid: Pubescent with stiff or rigid hairs.
Scabrous: Rough to the touch, covered with minute points or very short, stiff hairs.
Villous: Bearing long, soft hairs.

The Grass Floret

Callus: A thickened layer at the base of a floret at the point where it breaks off from the rachilla or tha main axis of the inflorecence.
Suture: The line where a grass floret breaks away from its stalk.
Sinus: The space between the margins of lemma at the base of a floret on the ventral side. (I).
Keel: An angle along the midnerve of a lemma or along the two nerves of a palea.
Glumes: The pair of bracts at the base of a spikelet, rarely only one.



GRAMINEAE - Grass family

The Inflorescence

Grass flowers or florets are in small clusters called **SPIKELETS**, each with two, rarely one, sterile bracts at the base, the **GLUMES**. The spikelets may be few to many-flowered, or in some species 1-flowered. The florets in a spikelet are arranged on a short axis, the **RACHILLA**. See fig. 3, A.

The spikelets are attached to a main central axis, the **RACHIS**. When the spikelets are attached to an unbranched rachis the inflorescence is a **SPIKE**, as in ryegrass. A **PANICLE** is a branched rachis, with the spikelets borne at the ends of the branches as in bluegrass and redtop. Sometimes the branches are very short as in timothy.

The Floret

A grass floret as it appears at time of flowering is shown in fig. 3, B. Sometimes the unopened florets are present in a seed sample, and the three long anthers on short filaments and the empty ovary fill out the lemma and palea so that it can be mistaken in the purity test for a floret containing a caryopsis.

Fig. 3, C shows a mature floret, the lemma and palea spread apart to show the two keel nerves of the palea. The hairs on the keels are often a diagnostic feature.

The glumes, lemma and palea may be variously modified. In many species all three parts are chaffy and similar in texture. In others the glumes may be hardened (indurate) and the lemma and palea tissue-like. In single-flowered spikelets the glumes and a sterile lemma may be tissue-like and the lemma and palea hardened. These types will be described on the pages that follow.

The Caryopsis

The caryopsis lies within the palea with the **HILUM** (ventral side) toward it, and the **EMBRYO** (dorsal side) toward the lemma. The embryo lies at the base of the caryopsis against a starchy endosperm. It consists of a **RADICLE**, **PLUMULE** (the sheath and first leaf), and **SCUTELLUM** (a modified cotyledon which acts as a food absorbing organ). Fig. 3, D and E.

The Seed Unit

When mature, the florets that make up a spikelet usually break apart, each retaining a segment of the rachilla directly above that to which it was attached. The mature floret with its attached rachilla segment is the unit considered the seed in many kinds of the grasses in commerce. In certain species the spikelets at maturity do not break apart and the entire spikelets fall from their glumes as, for example, some of the grama grasses, Bouteloua spp. In other species the entire spike falls from the main axis at maturity as in Bouteloua curtipendula, side-oats grama. (Chase, "First Book of Grasses" p. 57-58; Pohl, "How to Know Grasses", p.141).

The seed unit in a sample, therefore, may be a caryopsis, a fertile floret, a spikelet or a spike. It is important that these structures be recognized in order to distinguish the pure seed unit from inert material. (Rules, p. 39, par. 2.5)

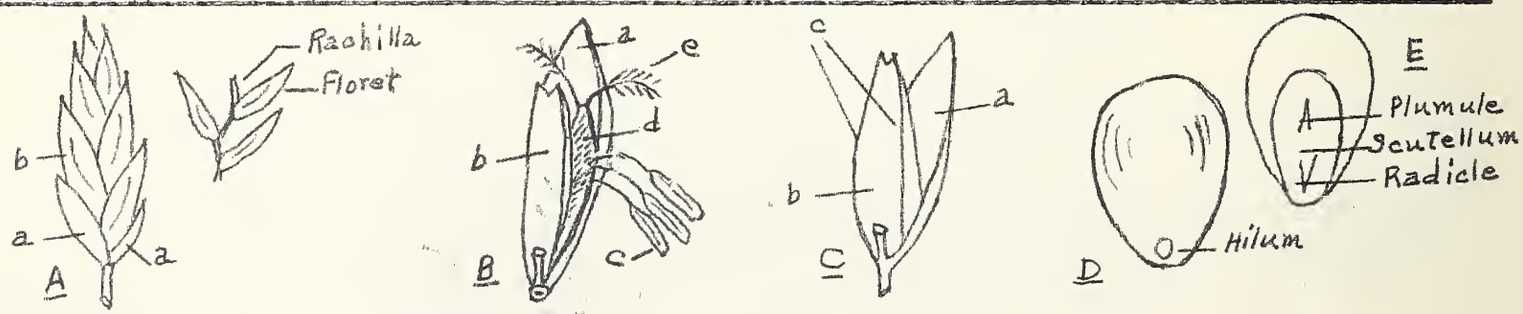


Fig. 3. - Structural features of the spikelet, floret and caryopsis.
A. Spikelet with six florets: (a) Glumes, (b) lemma of floret.
B. Floret at time of flowering: (a) Lemma, (b) palea, (c) anther, (d) ovary, (e) stigma.
C. Mature floret: (a) Lemma, (b) palea, (c) keel nerves of palea.
D. Caryopsis, ventral side. E. Caryopsis, dorsal side.

ANDROPOGON : SORGHUM
(Glumes hard, lemma and palea transparent)

The Andropogon - Sorghum group of grasses includes the cultivated sorghums, Sudan grass, Johnson grass, and numerous hay and range grasses.

The Inflorescence

The rachis of the inflorescense is jointed and the spikelets are borne in pairs at each node or joint, one of which is sessile and the other pedicellate. Fig. 4, A.

A joint consists of one sessile, fertile, 1-flowered spikelet, and one pedicellate spikelet which may be either sterile or staminate, and a segment of the rachis directly above that to which it was attached. See fig. 4, B. In some species the sterile spikelet is suppressed and only the pedicel is developed. 2/

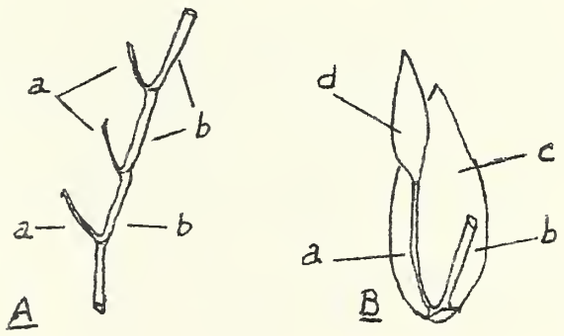


Fig. 4. - Structural features of the inflorescence.
A. Diagram of rachis and pedicels of three joints of the inflorescence: (a) Pedicel, (b) rachis.
B. Diagram of a single joint: (a) Pedicel, (b) rachis, (c) fertile, sessile spikelet, (d) sterile pedicellate spikelet.

The Fertile Spikelet

In this group of grasses the spikelet falls entire. The glumes are hardened and awnless, usually smooth and glossy, and completely enclose a thin and transparent lemma and palea. The thin lemma usually bears a weak awn which is easily detached in processing.

The hardened glumes may fit smoothly on the caryopsis and persist as in Sudan grass, Johnson grass, and certain varieties of the cultivated sorghums. In other varieties of sorghum the glumes may be loose and spread apart on the caryopsis so that much of the seed becomes hulled in processing.

The Seed Unit

The seed unit may be the naked caryopsis, as in the hulled sorghums, or it may consist of a single joint of the inflorescence. See fig. 4, B, and Manual figs. 25-32 and 185-194.

The character of the glumes, rachis and pedicel are important diagnostic features. It is, therefore, important to have a clear understanding of these structures.

2/ References for further study: First Book of Grasses by Agnes Chase, pp. 79-82.
How to Know the Grasses by R. W. Pohl, pp. 180-183.
Manual of the Grasses of the U. S. by A. S. Hitchcock.

PANICUM : SETARIA : ECHINOCHLOA
(Glumes tissue-like, lemma and palea hard)

This group includes a great number of widely distributed crop and weed plants. For a list of the kinds commonly encountered in seed testing refer to the Manual, pp. 214, 221, and 228.

The Inflorescence

The spikelets of Panicum and Echinochloa are mostly in open or compact panicles, those of Setaria mostly in narrow, dense and spike-like panicles. The spikelet is essentially 1-flowered, consisting of one fertile floret without a prolonged rachilla and one sterile or staminate floret, rarely both fertile.

The Spikelet (Fig. 5)

The spikelet in this group of grasses consists of two glumes and a sterile lemma, all thin and tissue-like in testure. The first glume is usually much reduced, the second glume and sterile lemma are longer and equal in length or the glume is shorter. For an example refer to the Manual, fig. 176 and other figures. The sterile lemma bears in its axil a hyaline palea which often adheres to the fertile palea against which it lies. This may be seen frequently in millet seed.

The lemma and palea of the fertile floret are hard and may be glossy or dull, smooth or roughened by fine tubercles or ridges.

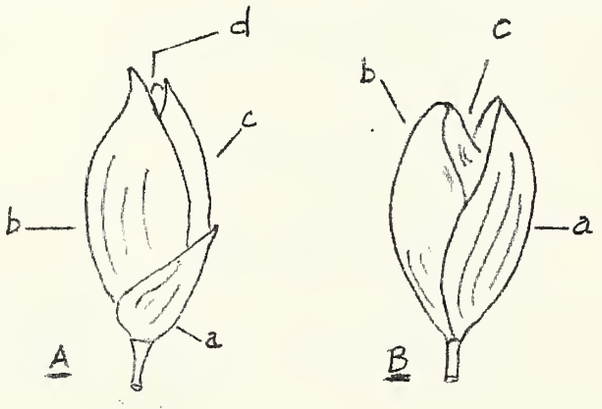


Figure 5.-Structure of the spikelet.
A. (a) First glume, (b) second glume, (c) sterile lemma, (d) fertile lemma.
B. Spikelet with 1st and 2nd glumes removed: (a) Sterile lemma, (b) lemma and (c) palea of the fertile floret.

The Seed Unit

The seed unit may be an entire spikelet, a fertile floret, or the naked caryopsis.

CRUCIFERAE - Mustard family

The mustard family comprises many kinds of plants which serve a variety of purposes, such as forage, vegetables and greens, oil and condiments. Many of the species are troublesome field weeds.

Inflorescence and Fruits 3/

The inflorescence is usually a raceme, with flowers having four petals spreading out in the shape of a cross and six stamens, two of which are shorter.

The fruits are in various forms. They may be dehiscent as in Brassica campestris (see p. 2, fig. 2, B), or indehiscent and breaking up into 1-seeded segments at maturity as in Coronopus and Raphanus raphanistrum (Manual p. 236 and fig. 336).

The Seeds

The seeds appear to be without endosperm, the large embryo filling the entire seed cavity. The embryo is usually curved and the cotyledons may be folded against the radicle in one of three ways. Study fig. 6 and the corresponding illustrations in the Manual. The position of the cotyledons in cross-section is often helpful in determining the species when the external features are in doubt.

It is necessary to have a clear understanding of these internal structures in order to distinguish between pure seed and inert material. Refer to the Rules for Seed Testing, p. 41, par. 2.10, a (2) and 2.10, b, (3).

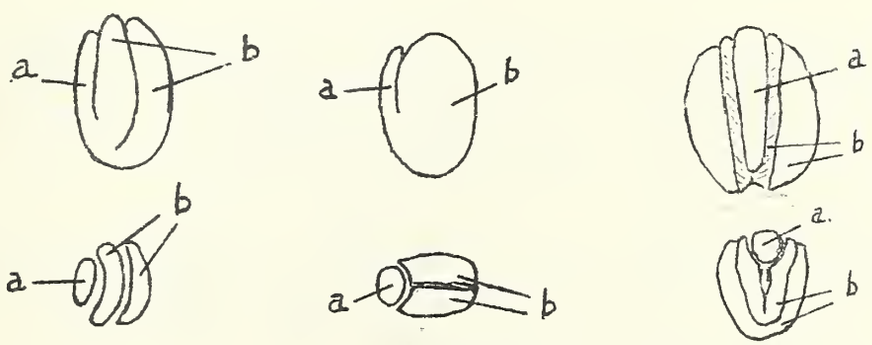


Fig. 6. Diagram of seeds with seed coats removed to show three positions of the radicle and cotyledons: Upper row, the embryo in side view, lower row in X-section. (a) Radicle; (b) cotyledons.

A.-Cotyledons flat against each other, with the broad side lying against the radicle. Ex., Camelina sativa, Lepidium campestre, Capsella bursa-pastoris.

B.-Cotyledons flat against each other, with the edge lying against the radicle. Ex., Camelina dentata, Thlaspi arvense, Lepidium virginicum.

C.-One cotyledon folded within the other and almost completely surrounding the radicle. Ex., Brassica spp., Eruca sativa.

The Seed Unit

The seed unit may be a true seed, or an indehiscent 1-seeded segment of a fruit.

3/ For a study of the inflorescence, fruits and seedlings of Brassica refer to: U.S.D.A. Circ. 857, Identification of Brassicas by Seedling Growth, Musil, 1950, and U.S.D.A. Miscell. Pub. No. 643, Distinguishing the Species of Brassica by their Seed, Musil, 1948.

LEGUMINOSAE - Pea family 4/

Inflorescence and Fruits

The pea family is characterized by the familiar pea-like flower. The ovary is mainly 1-celled, as in peas, but it may be 2 to several-celled by cross partitions.

The fruit is commonly a dehiscent 2-valved pod, as in peas, or indehiscent as in alfalfa. In some species the fruit is a loment, as in jointvetch or serradella (Manual figs. 354, 409). Refer to "Kinds of Fruits" p. 2.

The Seed (Fig. 7)

Seeds of the species under consideration appear to be without endosperm, the embryo filling the entire seed cavity. The radicle is bent back against the edges of the cotyledons, as shown in fig. 7. The shape of the seed is determined to some extent by the relative length of the radicle and the angle at which it lies against the cotyledons.

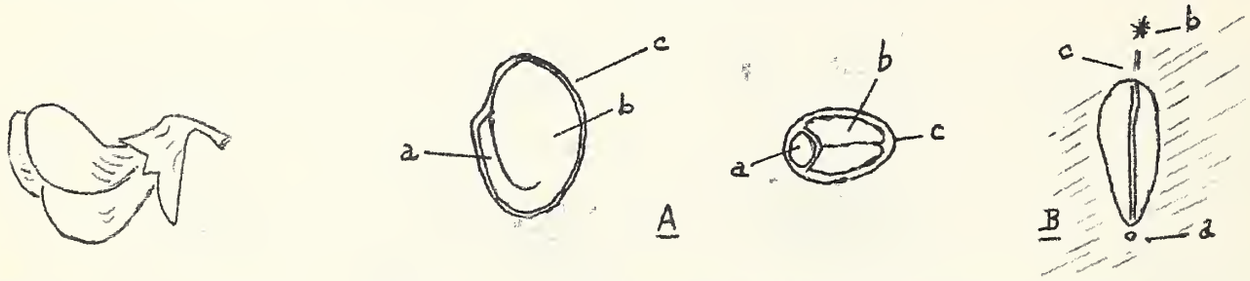


Fig. 7.- A. Seed of clover in longi-section and in cross-section; (a) Radicle, (b) cotyledons, (c) seed coat.
B. Detail of hilum: (a) Micropyle, (b) chalaza, (c) raphe.

The seed coat is usually thick and hard and often impermeable to water, which produces the hard seeds that are able to resist germination for long periods of time. There are some exceptions, as in peanut (Arachis) for example. Here the pericarp furnishes the protective covering and the seed coat is thin and papery.

The hilum (fig. 7, B) is usually an oval or oblong area, with a longitudinal groove or slit down the middle. The area may be minute as in some of the clovers, or it may be large as in vetch. In some species the hilum is obscured by a persisting layer of corky tissue, as in cowpeas and beans. The size, shape, and position of the hilum are important diagnostic features.

The chalaza is a place on an ovule where the nucellus unites with the outer integuments, and is always opposite the upper end of the cotyledons. In many of the legumes it is evident on the surface of the seed coat as a small wart-like elevation, usually darker in color than the seed coat. Its prominence or its position in relation to the hilum is an important diagnostic feature in some species, such as Hungarian vetch for example. Refer to Manual fig. 455 and p. 268, Plate 37.

The micropyle is a minute pore near one end of the hilum leading down to the nucellus. It appears to have no diagnostic value.

The raphe may be evident in certain species as a raised ridge between the hilum and the chalaza. It has no diagnostic significance in the species commonly encountered in seed testing.

The Seed Unit

The seed unit may be a true seed, a fruit, or segments of a fruit.

4/ For lists of crop and weed legumes refer to Manual pp. 142-143 and 237-258.

POLYGONACEAE - Buckwheat family 5/

RUMEX : POLYGONUM

The fruit in the buckwheat family is an achene (see p. 2). The black or brown, usually glossy, outer hull is the pericarp, the thin, dull brown tissue beneath it is the seed coat. Most of the seed cavity is filled with a white endosperm, against which the embryo lies. The embryo is large enough to be plainly visible with a hand lens and its position in relation to the endosperm is an important feature in distinguishing the fruits of the two genera.

Rumex (Fig. 8, A)

The achenes are brown or black, smooth and glossy, 3-sided, the three sides being approximately equal. In cross-section the angles between them may be obtuse, acute, or minutely winged.

The embryo lies in a groove against one of the sides of the endosperm.

Polygonum (Fig. 8, B)

The achenes may be flattened or 3-sided, the three sides usually unequal; color brown or black, smooth and glossy or finely roughened and dull.

The embryo lies in a groove in one of the angles of the endosperm.

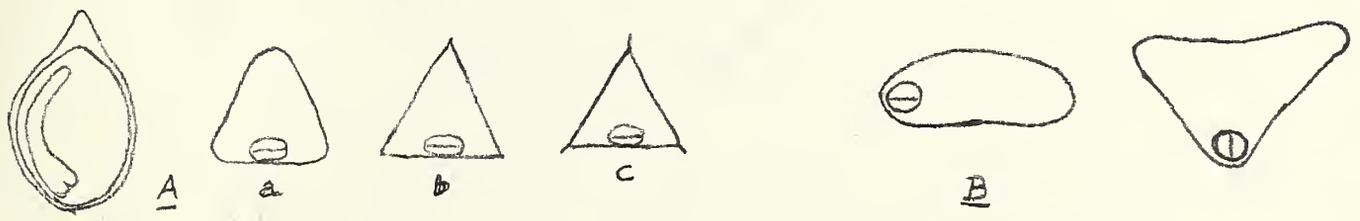


Fig. 8.- A. Achenes of Rumex in cross-section, showing position of embryo and types of angles: (a) obtuse, (b) acute, (c) minutely winged.
B. Achenes of Polygonum in cross-section, showing two shapes and the position of the embryos.

The Seed Unit

The seed unit is a fruit (achene), or occasionally a true seed.

For distinguishing pure seed and inert material refer to Rules for Seed Testing p. 40, par. 2.7, e and p. 41, par. 2.10, a. (1) and 2.10, b. (1).

5/ For a list of species commonly encountered in seed testing refer to the Manual p. 81 and figs. 227-243, and mimeographed seed keys.